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UNITED STATES ATOMIC ENERGY COMMISSION

A MODIFIED DECADE SCALER

Final Report on Project Authorization Number CMR-3-5

by

George N. Rupert

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Abstract

An automatic decade scaler which operates for a fixed number of counts has been developed for use with a Geiger tube. The elapsed counting time is read by a 115V AC clock to 0.01 minute. Manual operation is provided to allow the scaler to be run for a fixed time interval in which case every 10,000 counts are recorded by a Cyclotron recording meter. The instrument has a two pulse resolution time of 25 microseconds. Four decades in cascade are used in the scaler, one of which has a resolution time of 8 microseconds; the other three, a resolution time of 30 microseconds. Ten neon bulbs are used in each decade to indicate the count.

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The basic decade circuit used in this scaler is described in the September, 1946, R.C.A. Review by Grosdoff and in the instruction manual for R.C.A.'s WF-99B electronic counter. The decade designs were modified by substituting 12AU7 for 6J6 type tubes and using a fixed -75 volt bias supply. Some circuit values were also changed. A complete circuit diagram is included in this report. Advantages of the decade scaler are the convenience of having the counting information presented in the decimal system and the use of individual neon bulbs to indicate each integer of the decades. Automatic operation frees the operator from his stop watch and allows counting information to be advantageously computed in units of time per unit count while the percent error will remain constant for a fixed number of counts. A description of the decade circuit, the chassis, and the power supply circuits follows.

Each decade design consists of four direct-coupled biased multivibrators in cascade. The scaling factor of such an arrangement would be sixteen if it were not for the two feedback loops employed which reduce the scaling factor to ten. The feedback takes place from MV-3 to MV-2 on the fourth pulse and from MV-4 to MV-3 on the sixth pulse. See Plate 1.

Plate 2 shows the wave forms which may be observed with an oscilloscope on the plates of the 12AU7 tubes when negative periodic pulses are fed into the first stage of the decade. (A one hundred thousand ohm resistor in series with the oscilloscope pick-up lead prevents the input capacity of the oscilloscope from affecting the operation of the circuit.) MV-1 has no feedback connection and so has a scaling factor of two. MV-2 has a feedback connection from plate one of MV-3 to grid two of MV-2. On the fourth pulse the second triode of MV-2 starts conducting. The negative step produced at the plate of this triode triggers MV-3. The resulting negative step at the first plate of MV-3 is fed back to the second grid of MV-2 which turns off triode two of MV-2. On the sixth pulse the feedback operation is repeated this time with MV-3 and MV-4. All triodes return to their zero-set operating conditions on the tenth pulse and are ready to start the cycle over again. Ten one twenty-fifth watt neon bulbs in each decade indicate the count. The bulbs are connected to the plates of the multivibrators through resistors.

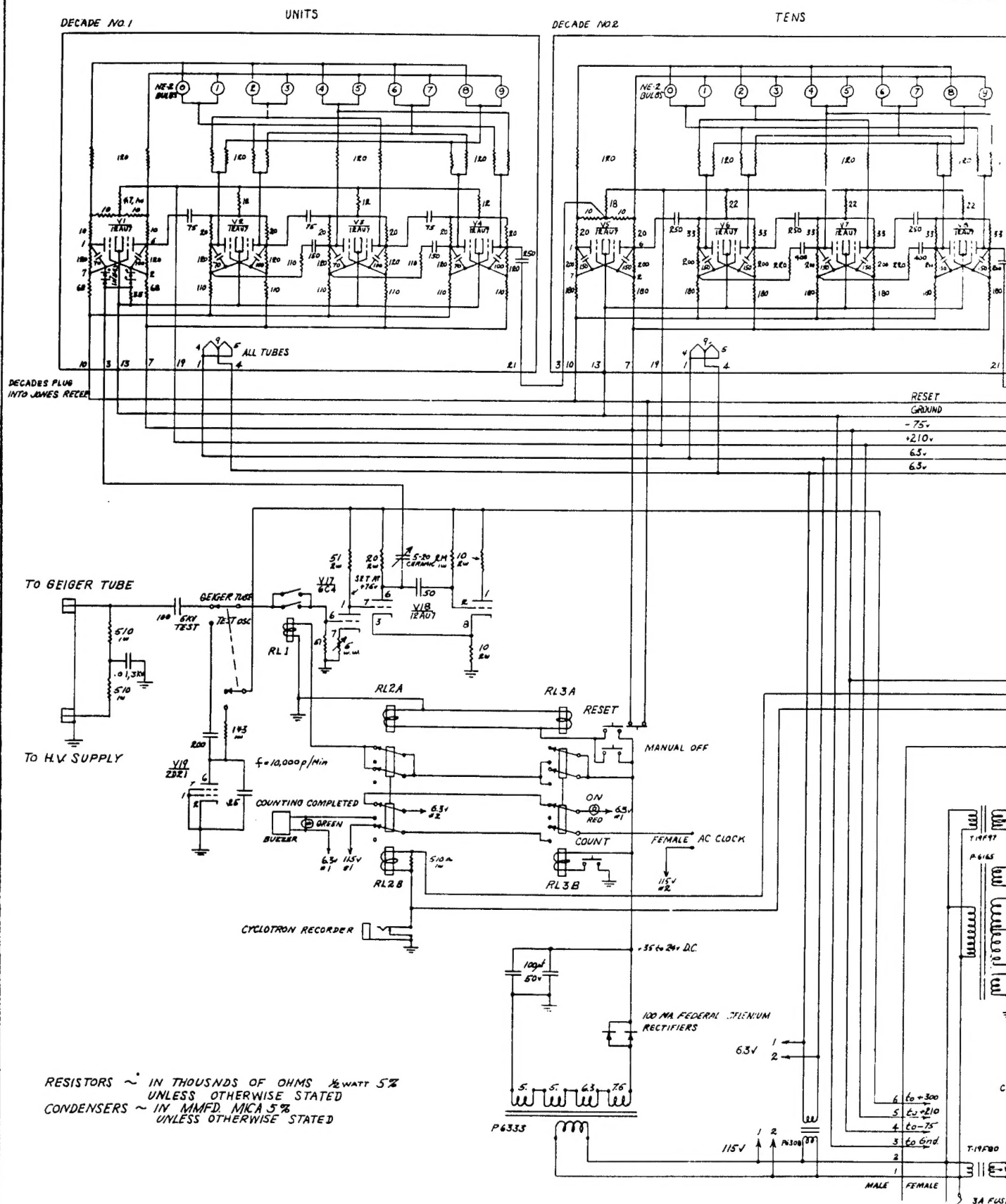
To show why only one bulb lights due to a single pulse the count zero will be considered. One electrode of the bulb is connected to plate one of MV-1 which is at a high potential at count zero. The other electrode is connected to plate two of MV-2 and plate two of MV-4, both of which are at a low potential at count zero. The potential difference is

sufficient to cause the bulb to light at a count of zero or ten but not for any other count. A similar situation exists for the other counts.

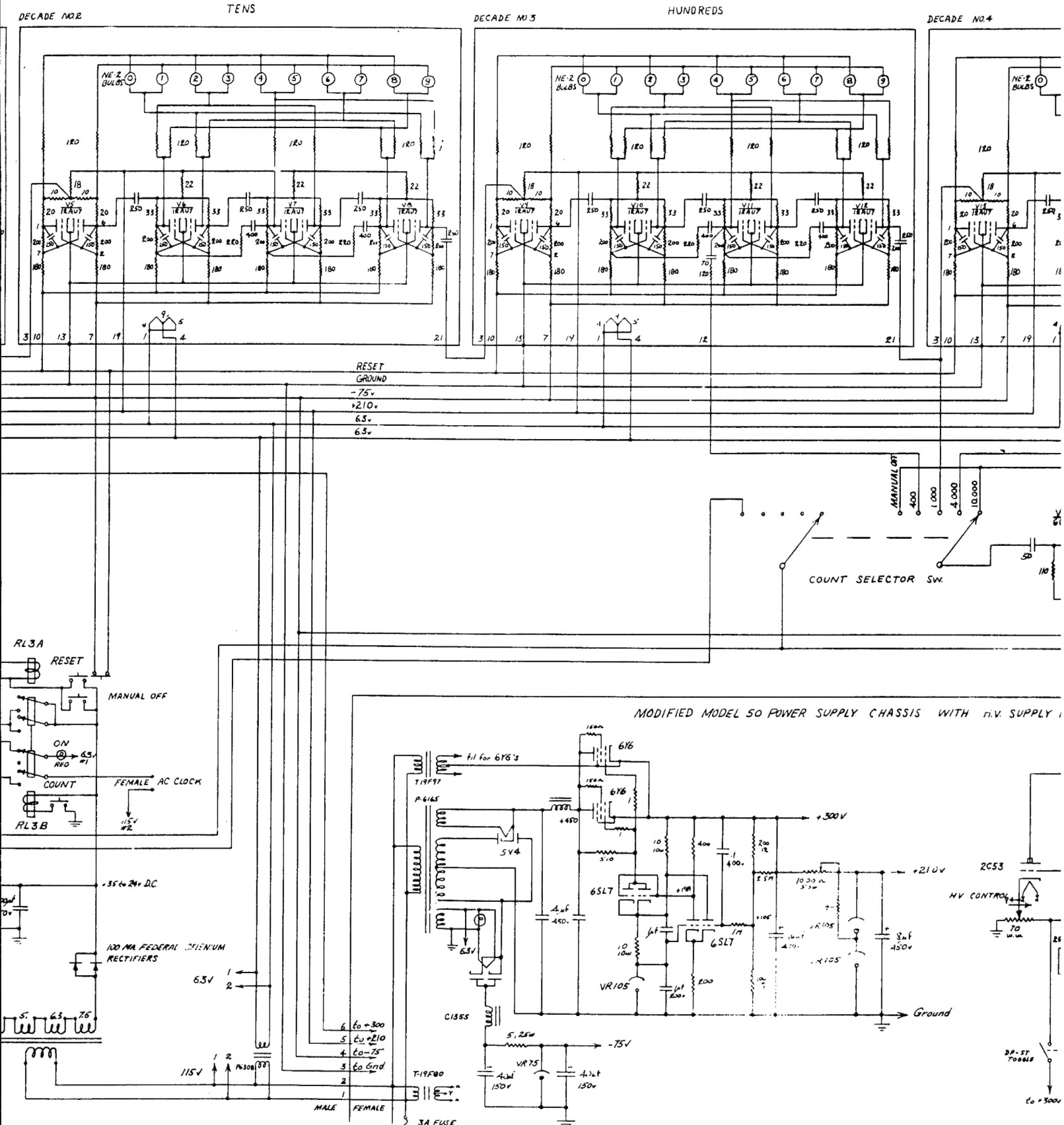
The four decades were built as plug-in units. This resulted in a saving of space and permitted uniformity in construction. Plates 3 and 4 show the location of parts on the front and back sides of the 8 microsecond decade. The same templates can be used for the 30 microsecond design although the parts values are different. Bakelite was used as the mounting plate and 4-40 cadmium plated screws were used as tie points. A twenty-four contact Jones plug in the bottom side of the decades served to connect the units to the circuit and also to hold them in position on the chassis.

Two crystal diodes, type 1N34, in series were used to couple to the grids of the first tube of the 8 microsecond decade. Two diodes were used in series so that the circuit would not become unbalanced if the back resistance of one should drop to a low value.

The scaler chassis contains the four plug-in decades, input circuit, test oscillator, and turn-off circuits. A description of the circuit follows: Negative pulses from either the Geiger tube or the test oscillator feed into V17 producing positive pulses at its plate which trigger V18, a one shot multivibrator. The negative pulses which appear at pin 6 of V18 are fed into decade No. 1 through an adjustable ceramic



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condenser. The plate current of V17 is controlled by the variable resistance in its cathode circuit to set the static grid voltage of V18, pin 7. This grid voltage should be set to + 75 volts. If it is raised too high the biased multi-vibrator will go into oscillation.

A panel switch is provided to allow the operator to count pulses from either a Geiger tube or from a 10,000 pulse per minute 2D21 thyratron oscillator which is used to test the operation of the instrument. To turn the scaler on, a push button operates relay RL-3B which actuates RL-1 closing the input circuit and turning on a pilot light and a 115V AC clock which records elapsed time.

Manual-off or automatic-off are available. The manual-off button is in parallel with the relay section of the reset button. When it is used the scaler is stopped but the decades are not zeroed. The reset button zeroes the decades and resets the relays for another cycle of counting.

When using the automatic-off, the count selector switch is set to either 400, 1,000, 4,000, or 10,000 counts. After the correct number of pulses have been counted a negative pulse from the appropriate decade feeds into V20 which amplifies and inverts it. The positive pulse is then used to fire V21, a thyratron tube, which causes a condenser to discharge through RL-2B turning the scaler off and the counting-completed pilot light and buzzer on.

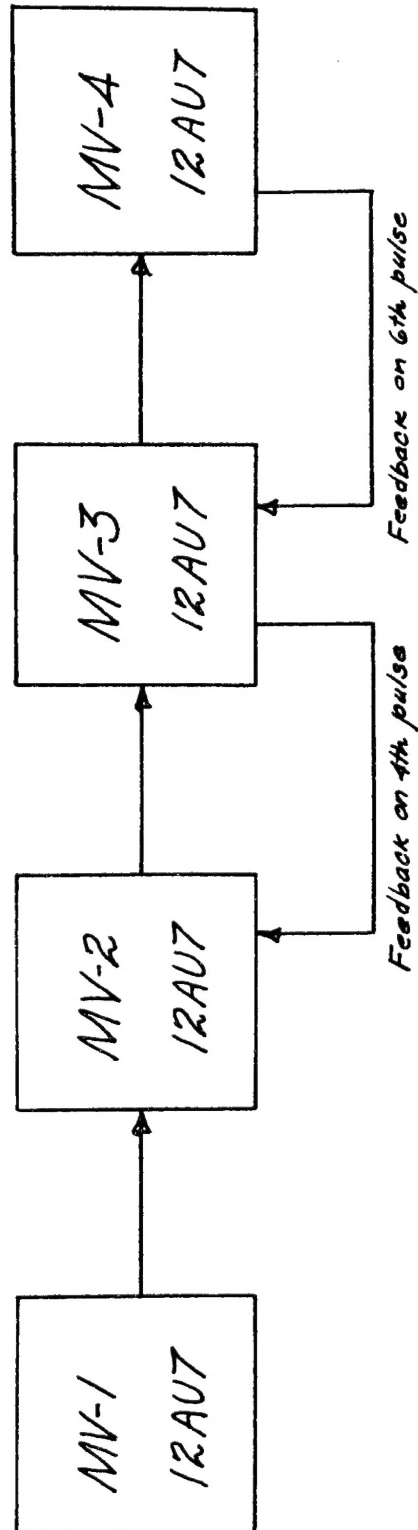
The instrument is made ready for another cycle of counting by pushing the reset button and manually zeroing the AC clock.

Multiples of 10,000 counts may be made by repeating the automatic cycle without resetting the AC clock.

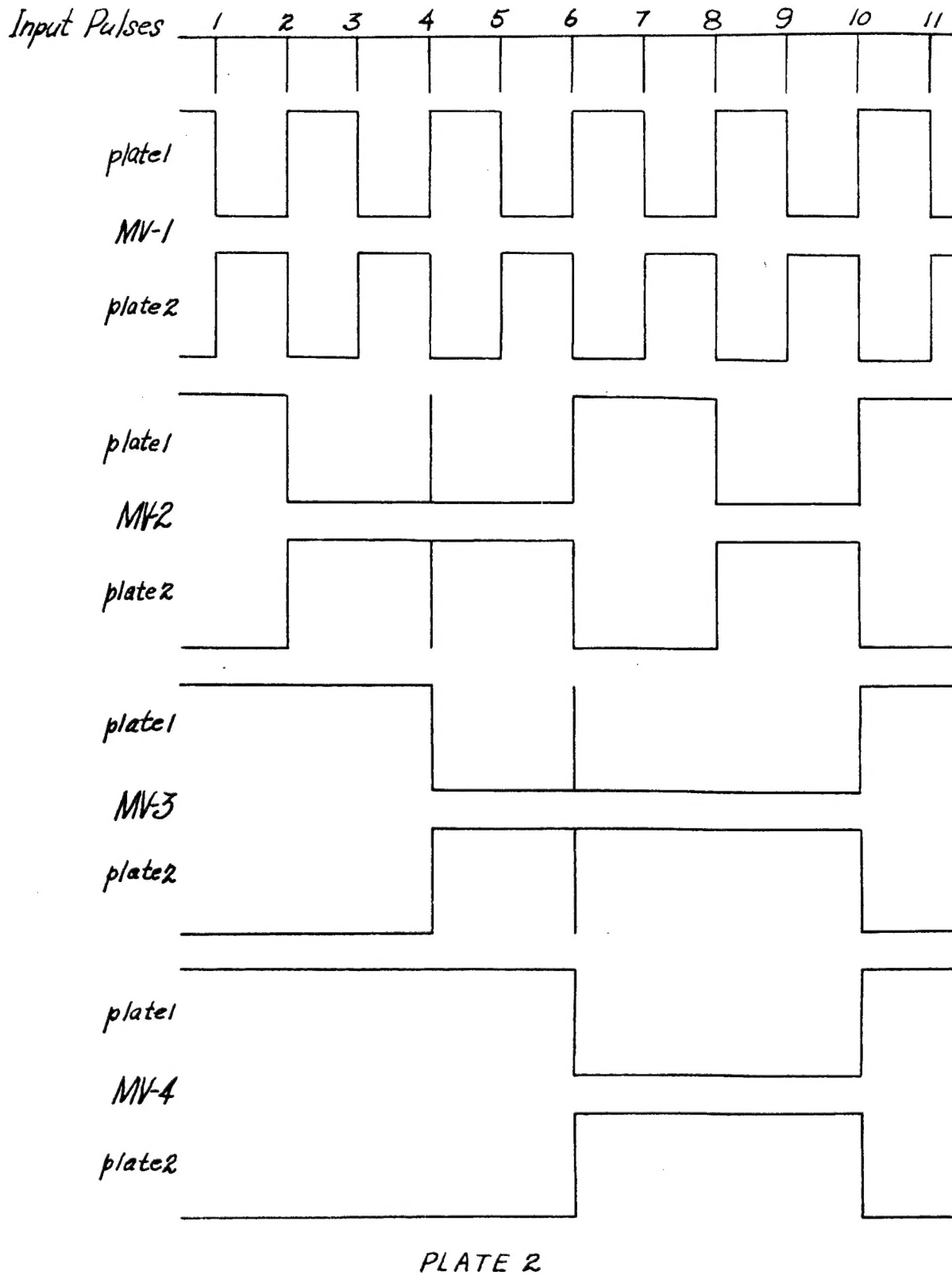
A Cyclotron recorder may be plugged into the turn-off circuit to record the number of 10,000 pulses counted in manual-off operation.

A model 50 power supply (reference LA-1002, Vol. 1, Part 1, Section B, 7.3-1) was used to power the instrument. It delivers regulated +300 volts. Two VR-105's in series supply +210 volts for the decades. The bias voltage for the decades, -75 volts, is supplied by a 6x5, VR-75 circuit. The regulated high voltage for the Geiger tube is furnished by a 2C53 tube shunt type regulator circuit over a range of 500 to 1550 volts.

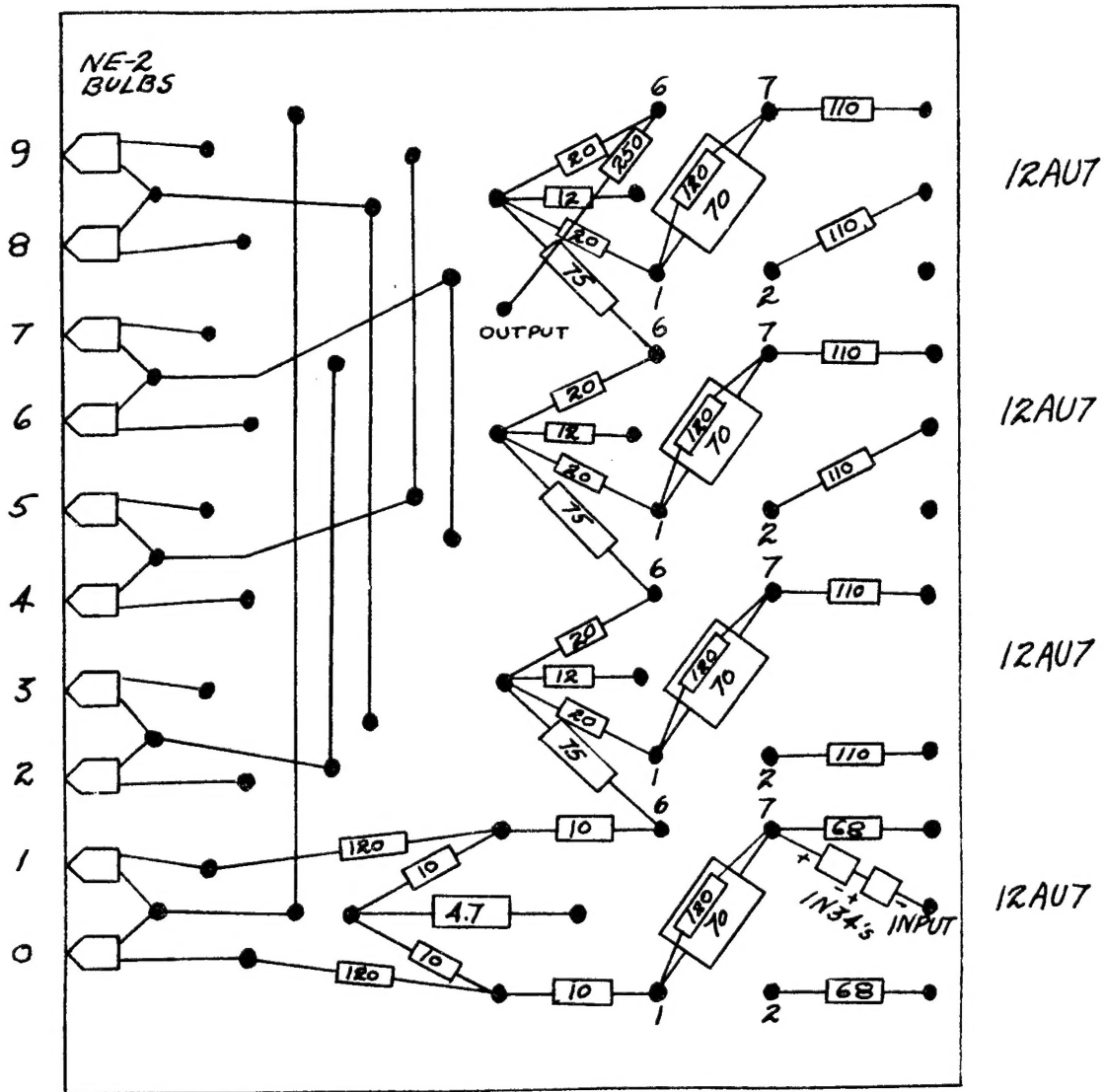
BLOCK DIAGRAM OF BASIC DECADE CIRCUIT



DECADE WAVEFORMS



FRONT VIEW OF 8 μ S DECADE



BACK VIEW OF 8 μ S DECADE